RJC
http://www.rasayanjournal.com

RASĀYAN *J. Chem.*
Vol.4, No.4 (2011), 944-946
ISSN: 0974-1496
CODEN: RJCABP

VERIFICATION OF THE MOLAR REFRACTION AS AN ADDITIVE AND CONSTITUTIVE PROPERTY OF BINARY LIQUID MIXTURES OF WATER-ETHANOL AND BENZENE-ETHANOL

Javed Khan, Maqdoom Farooqui and S.H.Quadri
Department of Chemistry
Maulana Azad College & Research Centre, Dr. Rafiq Zakaria Campus,
Rauza Bagh, Aurangabad.
*E-mail: javedkhanchem97@yahoo.com

ABSTRACT

Refractive indices, densities, molar refraction and electronic polarization (ϵ) of binary mixtures like ethanol with water, ethanol with benzene including those of pure liquids have been measured at room temperature (22ºC). Molar refraction for the above system was calculated theoretically. Experimental data and theoretical values of molar refraction were compared from these observations. It has been verified that the molar refraction is additive and constitutive property. Further, it is also observed that, the intermolecular interactions contribute nothing to molar refraction.

Keywords: Molar refraction, Refractive indices, Binary mixtures, Additive property, Constitutive property.

INTRODUCTION

Physical properties of a substance depend on the internal structure or the constitution of the molecule. Thus, the determination of properties such as refractive index, molar refraction, molar polarization, electronic polarization, etc. can provide valuable information's about the structure of molecules, binary, ternary mixture of liquid. Organic liquids are very important in various fields such as biomedical science, pharmaceuticals, solvent system for the refraction medium, chromatographic techniques and solvent system in spectroscopy. The present paper explains the result of experimental and the theoretical values of molar refractions, refractive indices and various other parameters for the liquid mixture of water-ethanol and benzene-ethanol.

Refractive indices and other related parameters are determined for the binary mixture of ethanol with water and Benzene with ethanol. Though a large number of preliminary investigations are available in the literature, but no comprehensive study has yet been reported related to binary studies.

EXPERIMENTAL

All the chemicals used were of L.R. grades. Chemicals were purified by distillation and only middle fraction were used in the experiment. Solutions were prepared by mole fraction method. Nine bottles of each system were kept in special air tight stopper glass bottles so as to avoid evaporation. The weighing was done by using electronic balance with precision of ±0.1 mg.

Refractive indices, densities of pure liquids and their binary mixture were measured by using Abbe Refractometer & densities bottle method respectively, at the room temperature (22ºC).

By using above experimental values of refractive indices and densities, molar refraction and electronic polarization was calculated by following formulae.

For pure liquid,

$$R_m = [(n^2-1)/ (n^2 +2)]M/d \quad (1)$$

Where, R_m- Molar refraction;n- Refractive index; M- Molar mass; d- density

and for binary mixture, equation (1) becomes-

$$R_{ms} = [(n^2-1)/ (n^2 +2)][(M_1x_1+M_2x_2)/d] \quad (2)$$

Where, R_{ms} - molar refraction of solution; n- Refractive index of solution; M_1 - Molar mass of 1st compound; x_1- mole fraction of 1st compound; M_2 - Molar mass of IInd compound; x_2 - mole fraction of IInd compound.

Table-1: For Pure Liquids

S. No.	Compound	Molar Mass	Refractive Index (n)	d, densities (g/ml)	$\varepsilon = n^2$ electronic polarization	Observed molar refraction Rm_{obs} (cm^3/mol)	Calculated molar refraction Rm_{cal} (cm^3/mol)
1.	H_2O	18.00	1.3534	1.0042	1.0084	3.8896	3.574
2.	C_2H_5OH	46.07	1.3797	0.8508	0.7239	12.5355	12.961
3.	C_6H_6	78.00	1.5218	0.8978	0.8060	26.5267	26.289

Table-2: For Water-ethanol

S. No.	Compound		Refractive Index (n)	$\varepsilon = n^2$ electronic polarization	densities (g/ml)	Rm_{obs} (cm^3/mole)	Rm_{cal} (cm^3/mole)
	Mole fraction of H_2O (x1)	Mole fraction of C_2H_5OH(x2)					
1	0.1	0.9	1.3829	1.9124	0.8607	13.2138	12.0223
2	0.2	0.8	1.3840	1.9154	0.8724	10.8420	11.083
3	0.3	0.7	1.3840	1.9154	0.8841	09.9562	10.145
4	0.4	0.6	1.3830	1.9127	0.8968	09.0640	09.206
5	0.5	0.5	1.3829	1.9124	0.9130	08.1824	08.074
6	0.6	0.4	1.3808	1.9066	0.9283	07.3077	07.3288
7	0.7	0.3	1.3787	1.9008	0.9428	06.4707	06.3901
8	0.8	0.2	1.3745	1.8893	0.9675	05.5794	05.451
9	0.9	0.1	1.3648	1.8627	0.9841	04.7212	04.513

Table-3: For Benzene-ethanol

S.No.	Compound		Refractive Index (n)	$\epsilon = n^2$ electronic polarization	Densities (g/ml)	Rm_{obs} cm^3/mole	Rm_{cal} cm^3/mole
	Mole fraction of Benzene(x_1)	Mole fraction of Ethanol(x_2)					
1.	0.1	0.9	1.3946	1.9455	0.8227	14.3525	14.2938
2.	0.2	0.8	1.4198	2.0158	0.8362	15.8714	15.6266
3.	0.3	0.7	1.4324	2.0158	0.8449	17.1019	16.9594
4.	0.4	0.6	1.4459	2.0906	0.8533	18.3979	18.2922
5.	0.5	0.5	1.4574	2.1240	0.8588	19.7014	19.6250
6.	0.6	0.4	1.4720	2.1668	0.8663	21.1039	20.9578
7.	0.7	0.3	1.4825	2.1978	0.8730	22.3854	22.2906
8.	0.8	0.2	1.4974	2.2437	0.8789	23.9115	23.6234
9.	0.9	0.1	1.5146	2.2940	0.8883	25.4155	24.9562

RESULTS AND DISCUSSION

Taking into account the observation of Table-1, 2 and 3, it is concluded that the experimental values of molar refraction of both systems are in good agreement with the calculated values of molar refractions. Also, intermolecular interactions do not play any role in the contribution of molar refractions. This further confirmed that the contribution for molar refraction is only due to the atoms and bonds present in the molecules or mixtures.

To summarize, it is verified that molar refractions (Rm) is an additive and constitutive property and the refraction of molecule is sum of contribution of atoms (atomic refraction) and bonds (bond refraction).

REFERENCES

1. Samuel H. Maron and Carl F. Prutton, Principle of Physical Chemistry, 4th edition, Amerind Publishing Co. Pvt. Ltd,691.
2. LLYOD N.Ferguson, The modern structural theory of organic chemistry, Prentice-Hall of India Pvt. Ltd, New Delhi,196(1969).
3. P.W.Atkins, Physical chemistry, Oxford University Press, Oxford Melbourne Tokyo, 6th edition, 654(1998).
4. Arthur I. Vogel, A text book of Practical Organic Chemistry including Qualitative Analysis, New impression with corrections and additions, 3rd edition, 1031.

[RJC-806/2011]